

# Fully printed multi square meter large organic solar cell modules for real energy production

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eliminate the detrimental $Cu^{2+}$ ions, optimizing film thickness and selenization temperature, we have improved the power conversion efficiency to 8.3%.[3] Characterization of the absorber film shows a pure kesterite structure but with a non-ideal morphology consisting of small grain bottom layer and large grain top layer. Recently, by adding a small amount of additives to the precursor solution, more uniform CZTSSe absorber films with larger grains and smoother surface are obtained and a total area efficiency of 10% has been achieved without an antireflective coating. This is the most efficient CZTSSe absorber material fabricated from all methods rather than hydrazine ink. Our results demonstrate that highly efficient kesterite solar cells can be realized from simple molecular precursor solution in environmental benign solvent, making this method the most promising approach for low cost earth abundant solar cells.

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**Keywords:** kesterite, CZTSSe, photovoltaic cells, non-toxic solvent, abundant.

113

OP-41

## Fully printed multi square meter large organic solar cell modules for real energy production

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The majority of lab-scale organic solar cells (OPV) are very small with < 0.5 cm2 [1] using ITO glass, spin coating, evaporation, inert atmosphere, and optimum conditions. Obviously, the cells can lead to record efficiencies – but they are far beyond real world applications often proclaimed by the authors. Transfer to large-scale devices with an appropriate power output is hardly possible.

Here, we present the route to literally infinite large organic solar cell modules with hundreds of Watts output – fully roll-to-roll (R2R) produced under vacuum-free ambient conditions.

The substrate is based on printed silver grids, PEDOT:PSS, and zinc oxide [2] and enables a fast production with up to 20 m/min and has decreased embodied energy compared to ITO-based substrates. Model cells with at least 1 cm2 are fabricated on a rollcoater, which allows easy transfer to the R2R line for larger test modules (> 50 cm2).

Furthermore, we are able to produce infinite long modules based on thousands of serially connected cells. All R2R coating and printing processes of active layer, PEDOT:PSS and silver electrodes are carried out with several m/min. The serial connection is completed throughout the print run due to an optimized pattern layout. The advantage of the so-called Infinity concept is the fabrication of high-voltage OPV modules with

active areas beyond square meters (21000 cells = 14.7 m2, 100 m long) and stabilized power outputs of > 220 W (active layer P3HT:PCBM). The module has only two terminal connectors for minimized wiring during the setup of module arrays. The installation of a 100 m long module takes less than one minute. A parallel-connected array with outputs > 1.3 kW and rather low efficient material (< 2%) was built.[3]

Here, we will present the latest results of this fully functional strategy for energy production based on OPV.

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OP-42


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## Conjugated Polymer/PCBM Bilayer Heterojunction Polymer Solar Cells


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Bulk heterojunction (BHJ) type photoactive layer is widely used for the fabrication of organic solar cells. The blended solution of electron donor and acceptor is used to form BHJ layer. The performance of BHJ solar cell is influenced by proper formation of interpenetrated nanoscale morphology between donor and acceptor organic semiconductors. The nano morphology formation is sensitive to various optimization conditions such as donor/acceptor blending ratio, processing additive and solvents.